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Measurement of UO_2F_2 samples containing 2 different isotopic compositions

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Technical report prepared for the JRC-EC-IRMM
under Action Sheet 36

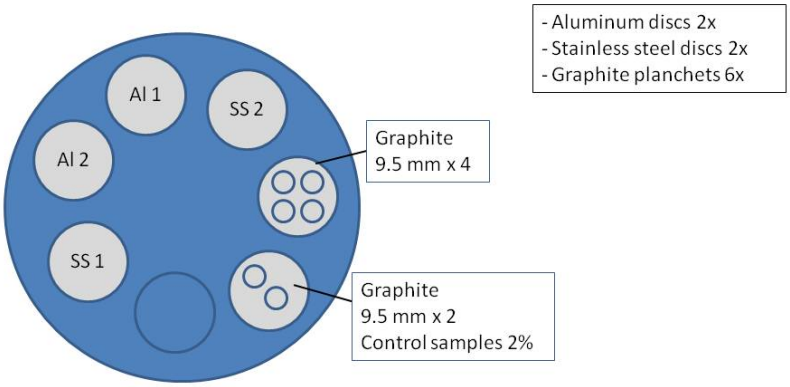
Disclaimer and auspices

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 and under the auspices of the European Commission, DG Joint Research Centre under Action Sheet 36. The analyzed samples were generated by the IRMM expressly for the purpose of this experiment and we have no evidence that fugitive emissions from a uranium enrichment facility would, or would not, appear similar to the analyzed samples.

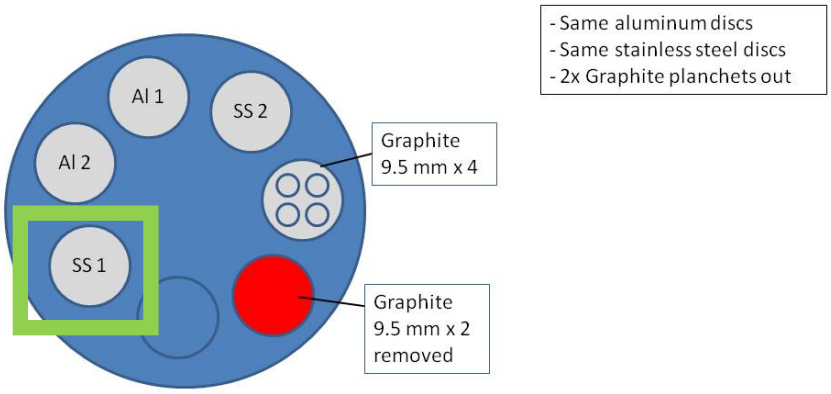
Measurement of UO_2F_2 samples containing 2 different U isotopic compositions (June 2010)

Samples prepared at IRMM in aerosol deposition chamber

Double deposition part 1: LEU 0.0208026 ± 0.0000337

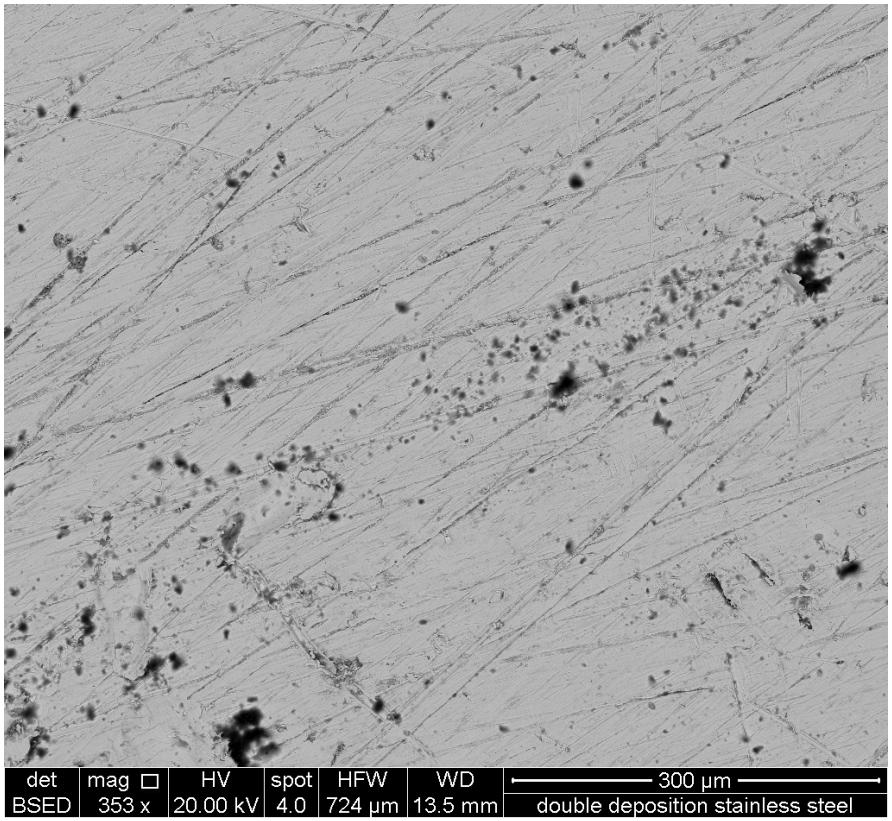


Double deposition part 2: HEU 0.254423 ± 0.002339

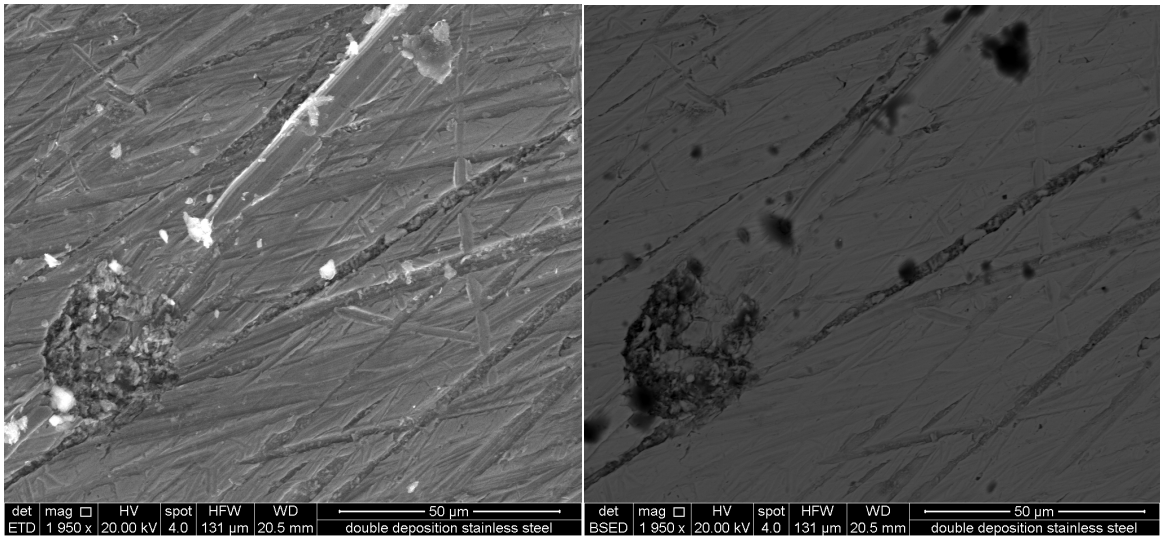


Stainless steel sample measured by SEM-EDX

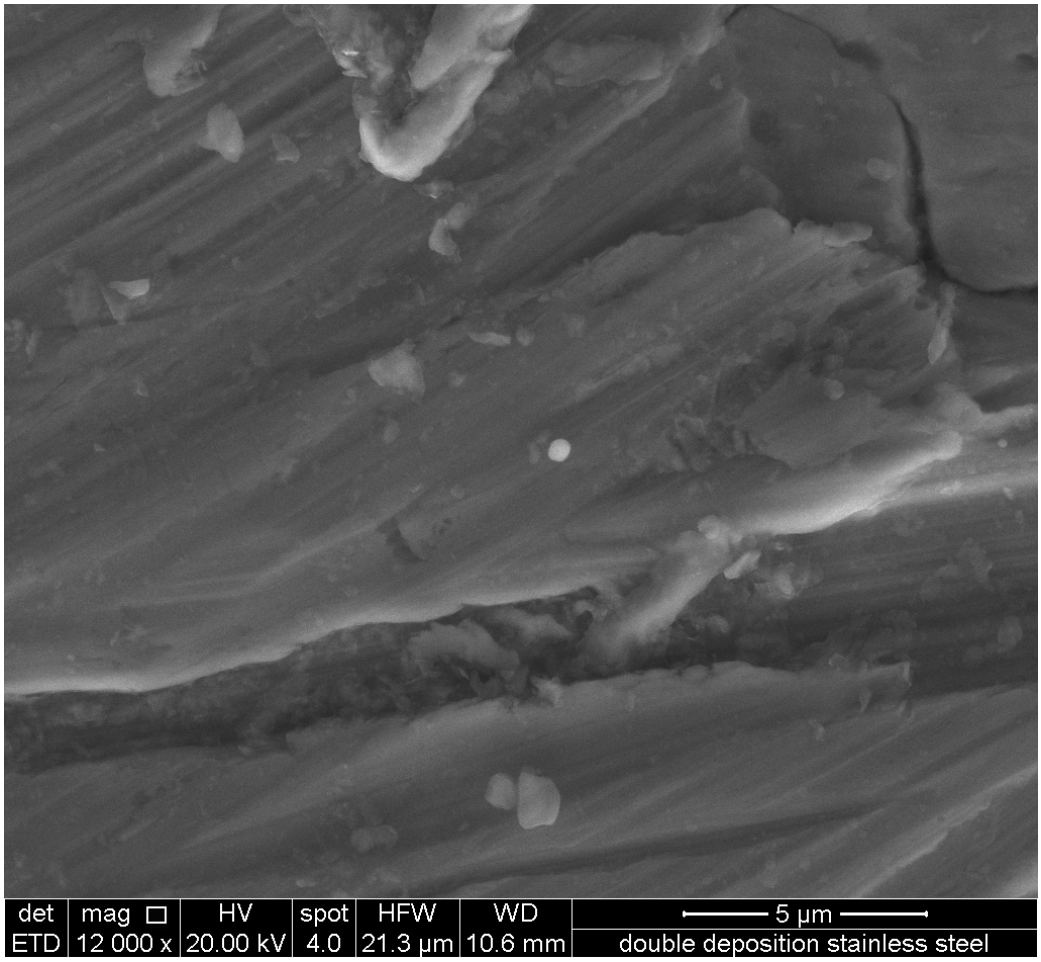
- Scanning electron microscope images show that the stainless steel surface is very rough, with many scratches
- A lot of particles that are NOT uranium, as shown on backscattered electron images
- Energy-dispersive X-ray analysis shows main components to be Fe, Cr, Ni, characteristic of stainless steel
- Confirmed at least 6 U-containing particles, these particles are typically ~ 500 nm in size



Backscattered electron image showing many scratches on stainless steel surface



Secondary (left) and backscattered electron (right) images at 1950x showing scratches and low-Z crud material, but no U



Secondary electron image of a submicron-sized uranium particle (center)

NanoSIMS analyses carried out on 6/29/2010

Fcp = 571 nA
Fco = 70 pA at L1: 0

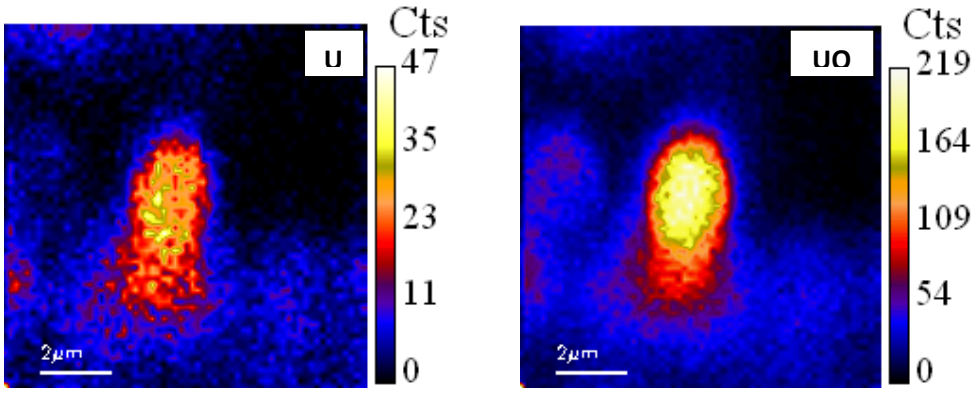
Particle density very low, UO2F2 particles stored in dry air (< 20% RH)

Measurement conditions

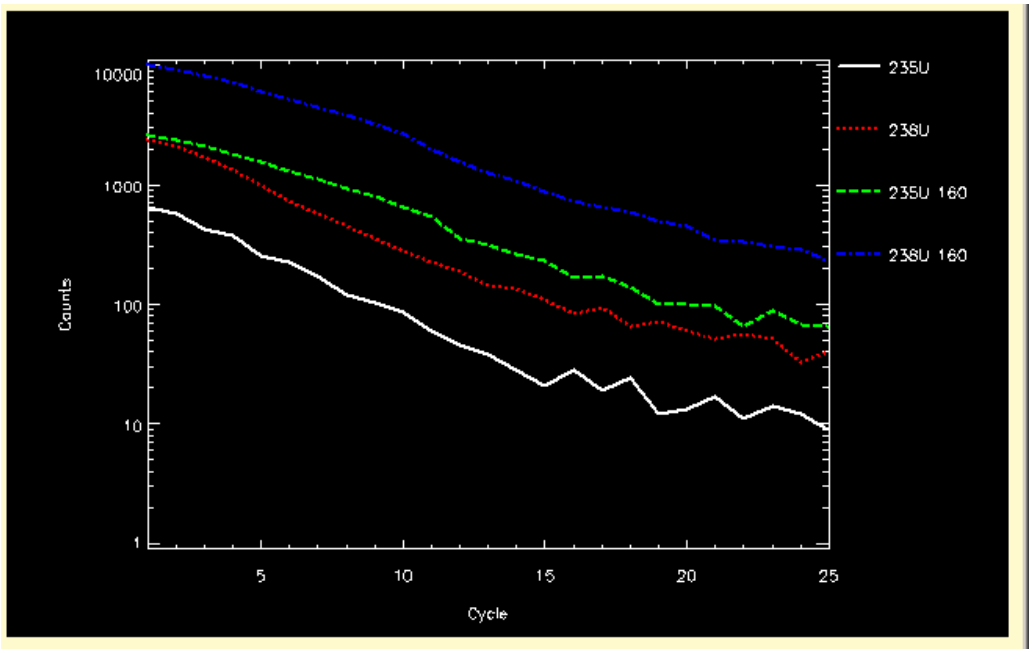
EM4	EM5
	235
238	251
	254

1s wait time between each magnetic field jump
64 x 64 pixels - 1ms/pxl
10 micron x 10 micron rasters
10-40 cycles
L1:0 and L1:1600
9 particles measured in center and on edge of stainless steel

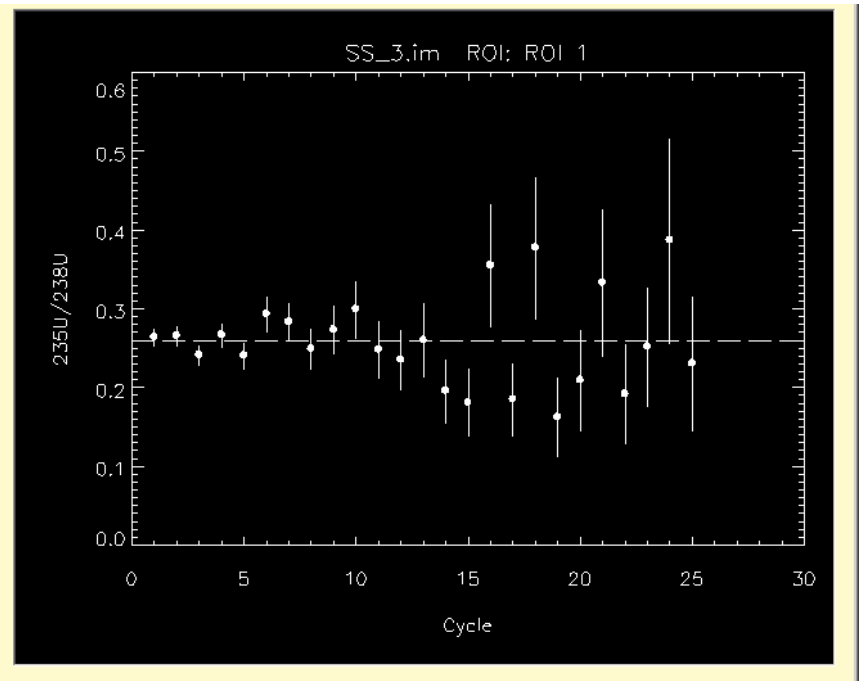
Particle #3 - average 235/238 raio = 0.2605 ± 0.0051 (HEU)



Depth profile particle #3 25 cycles

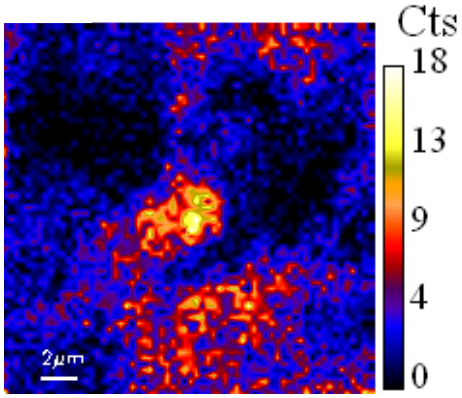


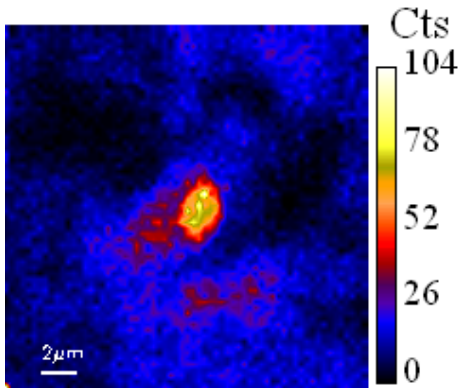
235U/238U ratio variations over 25 cycles



⇨ As count rate drops, spread on ratio becomes larger

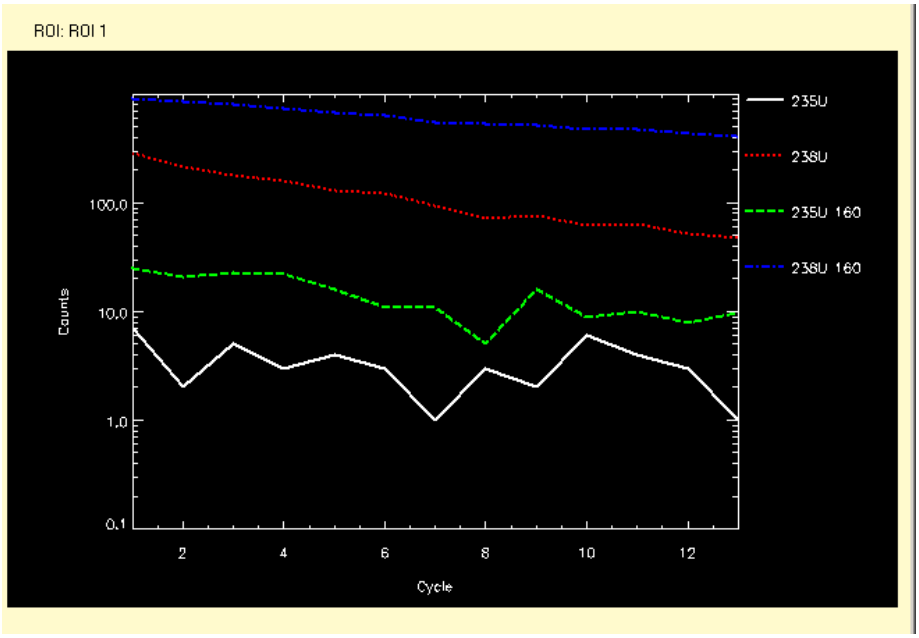
Particle #5 - average 235/238 ratio = 0.0270 ± 0.0041 (LEU)



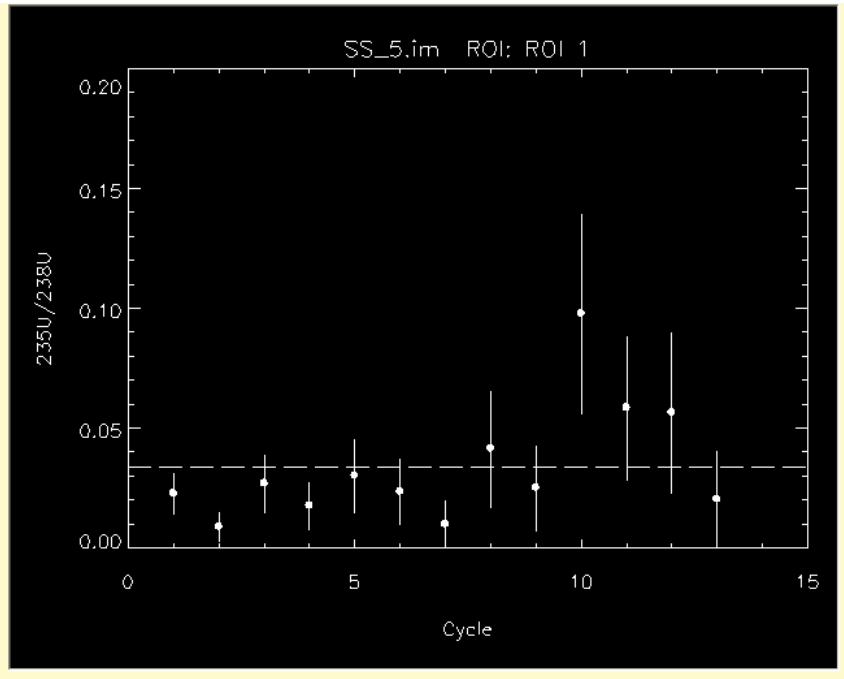


U **UO**

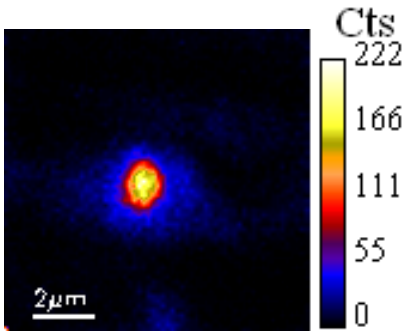
Very small particle, large U background



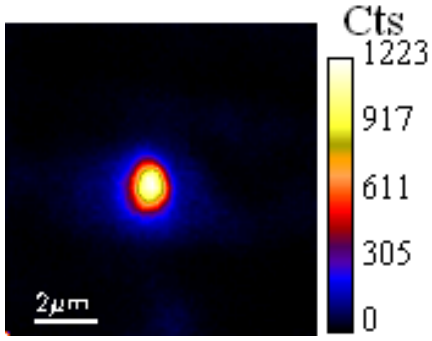
Log scale



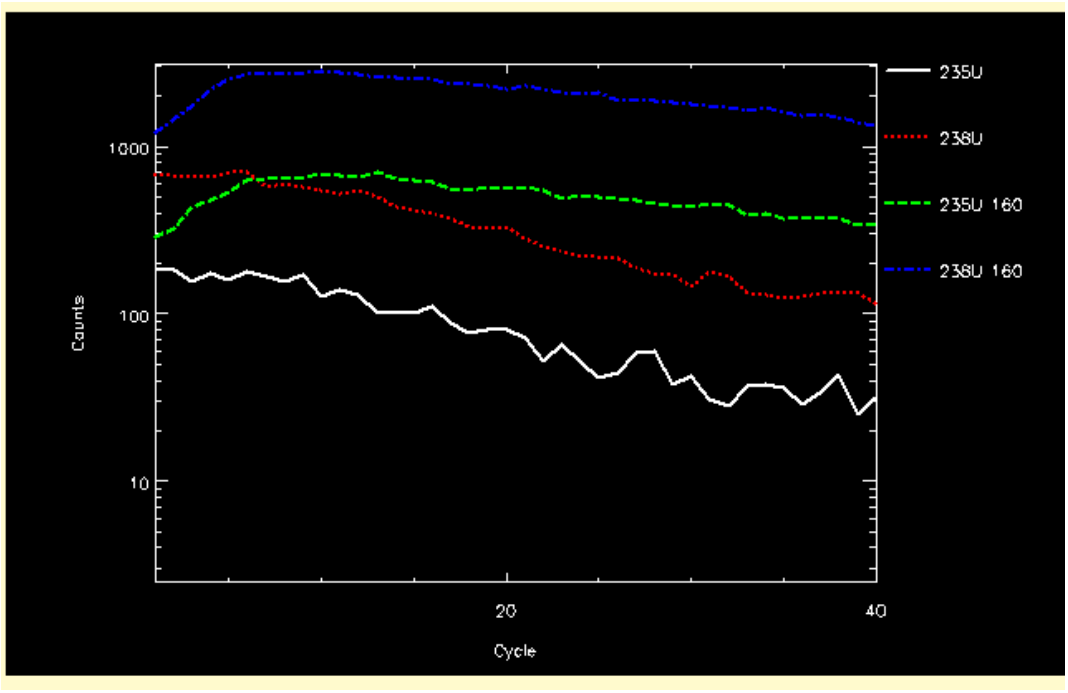
Particle #7 - average 235/238 ratio = 0.2494 ± 0.0047 (HEU)



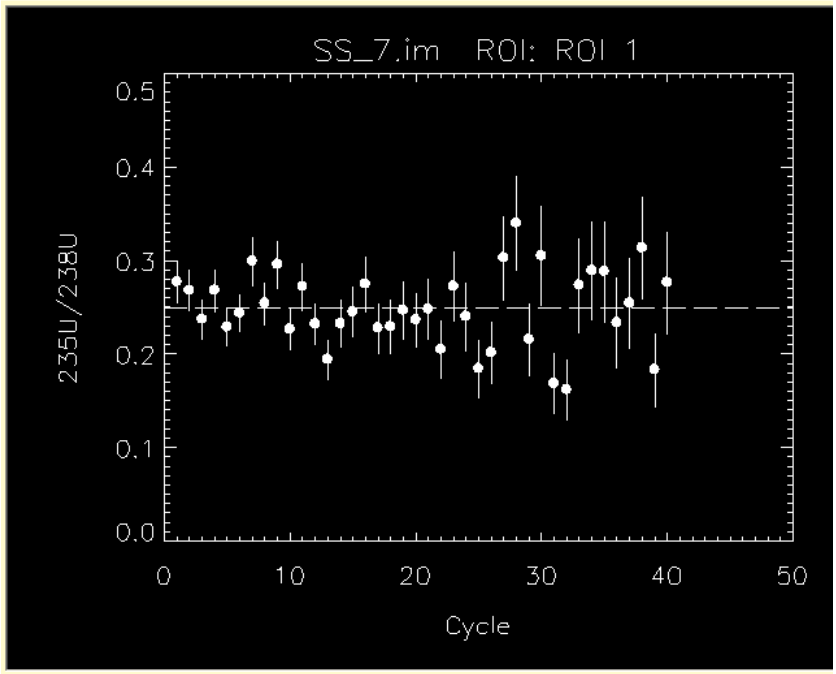
U



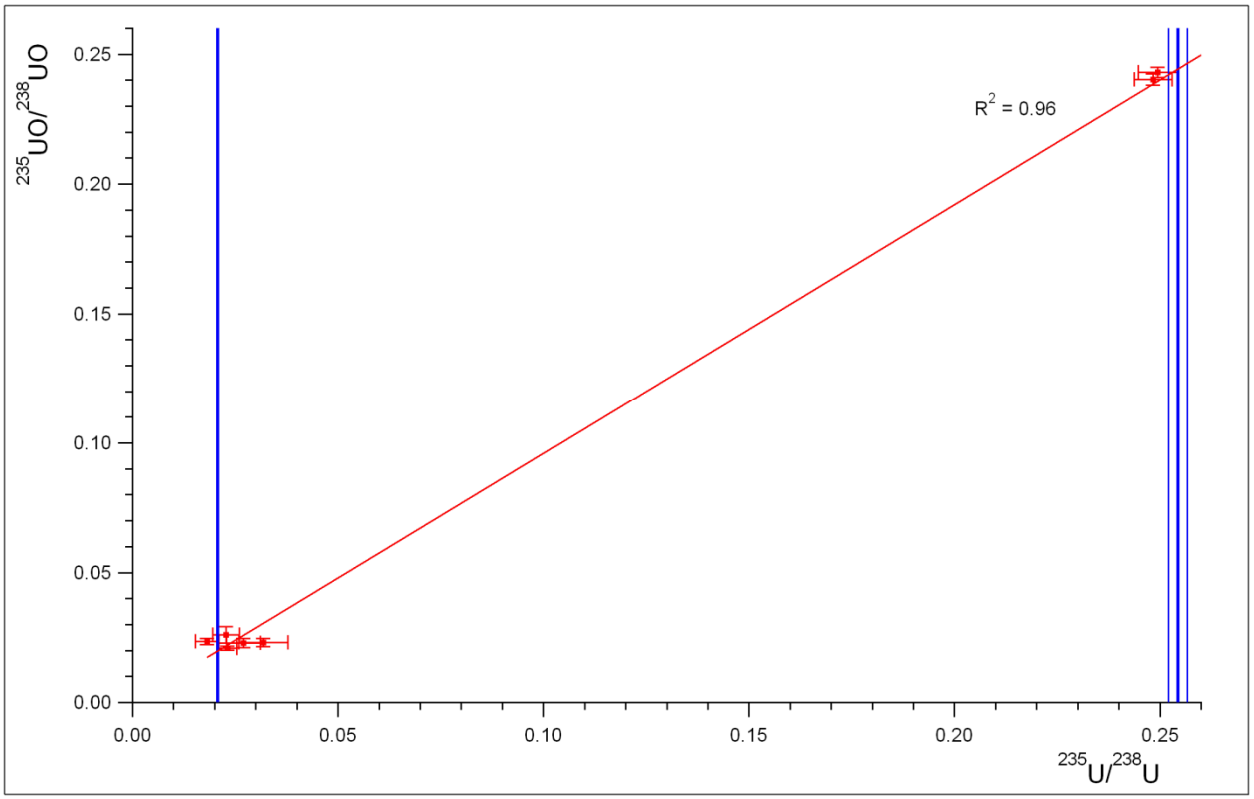
UO


235U
238U
235U 160
238U 160
1000
100
10
Counts
20
40
Cycle

L1 = 0

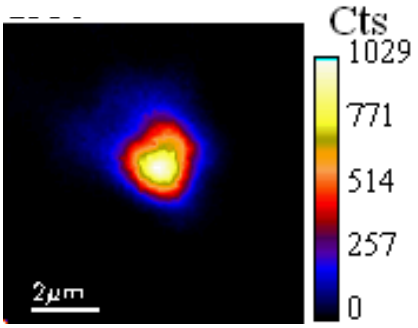

SS_7.im ROI: ROI 1
0.5
0.4
0.3
0.2
0.1
0.0
235U/238U
0
10
20
30
40
50
Cycle

Overview of all particles analyzed

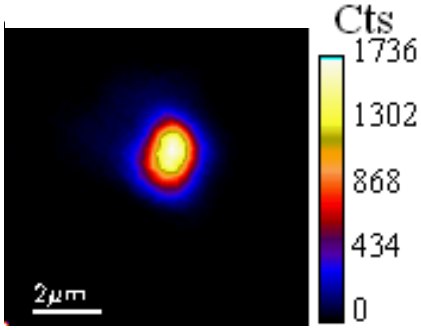


Blue lines indicate 235/238 ratio of reference materials used for double deposition (LEU and HEU)

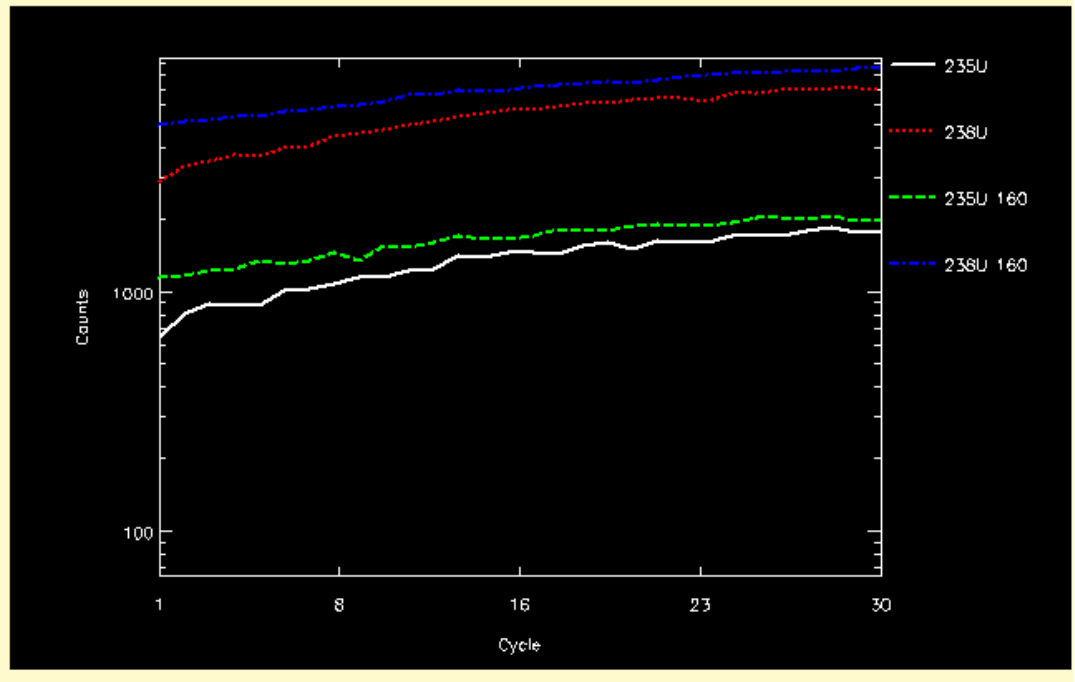
Verified isotopic composition of 20% enriched sample (1 isotopic composition)

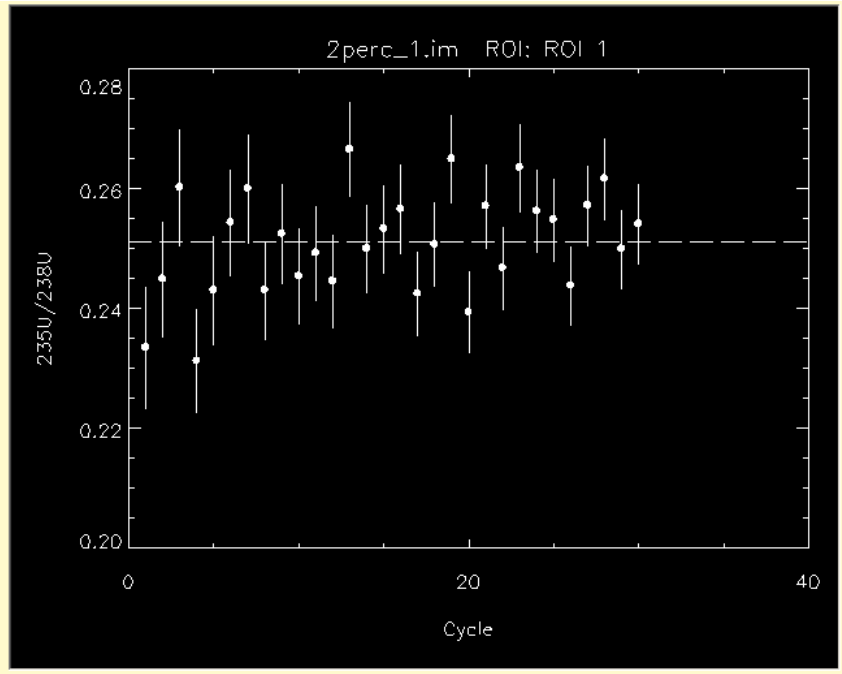


U



UO





Average 235/238 ratio = 0.2516 ± 0.0014 (HEU) within 1 stdev of reference value